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A Driving Decision Strategy Based on Machine Learning for an Autonomous Vehicle

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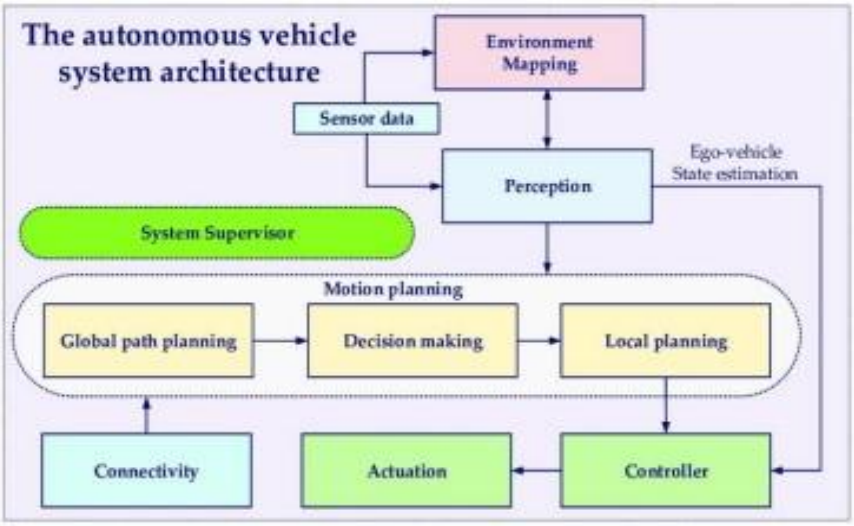
ABSTRACT
The developing technology has made a big stage for several inventions or creations to be formed, worked on, functionalized and used for better improvement of human's life. The idea of creating an autonomous vehicle is to improve the human driving skills by replacing human's driving and using artificial intelligence so that there is better usage of safety rules; avoid accidents, proper functioning of roads with well managed traffic and roads. A current autonomous vehicle determines its driving strategy by considering only external factors (Pedestrians, road conditions, etc.) without considering the interior condition of the vehicle. To solve the problem, this project proposes "A Driving Decision Strategy (DDS) Based on Machine learning for an autonomous vehicle" which determines the optimal strategy of an autonomous vehicle by analyzing not only the external factors, but also the internal factors of the vehicle (consumable conditions, RPM levels etc.). The DDS learns a genetic algorithm using sensor data from vehicles stored in the cloud and determines the optimal driving strategy of an autonomous vehicle. This project compared the DDS with MLP and RF neural network models to validate the DDS.

Keywords: External Condition, Internal Condition, Driving Decision Strategy.

1. INTRODUCTION

Currently, global companies are developing technologies for advanced self-driving cars, which is in the 4th stage. Self-driving cars are being developed based on various ICT technologies, and the principle of operation can be classified into three levels of recognition, judgment and control. The recognition step is to recognize and collect information about surrounding situations by utilizing various sensors in vehicles such as GPS, camera, and radar. The judgment step determines the driving strategy based on the recognized information. Then, this step identifies and analyzes the conditions in which the vehicle is placed, and determines the driving plans appropriate to the driving environment and the objectives. The control step determines the speed, direction, etc. about the driving and the vehicle starts driving on its own. An autonomous driving vehicle performs various actions to arrive at its destination, repeating the steps of recognition, judgment and control on its own [1]. However, as the performance of self-driving cars improves, the number of sensors to recognize data is increasing. An increase in these sensors can cause the in vehicle overload. Self-driving cars use in-vehicle computers to compute data collected by sensors. As the amount of the computed data increases, it can affect the speed of judgment and control because of overload. These problems can threaten the stability of the vehicle. To prevent the overload, some studies have developed hardware that can perform deep running operations inside the vehicle, while others use the cloud to compute the vehicle's sensor data. On the other hand, existing studies use only real-time data such as images and sensor data currently collected from vehicles to determine how the vehicle is driving. This paper proposes a Driving Decision Strategy (DDS) Based on Machine learning for an autonomous vehicle which reduces the in-vehicle computation by generating big data on vehicle driving within the cloud and determines an optimal driving strategy by taking into account the historical data in the cloud. The proposed DDS analyzes them to determine the best driving strategy by using a Genetic algorithm.

2. METHODOLOGY



Clearly define the problem statement, which is to improve the driving strategy of autonomous vehicles by considering both external factors (e.g., pedestrians, road conditions) and internal factors of the vehicle (e.g., consumable conditions, RPM levels). Identify the limitations of current autonomous vehicle systems in considering internal vehicle factors and the potential benefits of addressing this limitation.

Literature Review:

Conduct a thorough review of existing research and literature on autonomous vehicles, machine learning techniques, genetic algorithms, and driving decision strategies. Identify relevant studies, methodologies, and techniques used in similar projects.

Data Collection:

Gather sensor data from autonomous vehicles, including both external environment data (e.g., images, Lidar, GPS) and internal vehicle data (e.g., engine parameters, diagnostics). Ensure the collected data represent diverse driving scenarios and conditions.

Data Preprocessing:

Clean and preprocess the collected data to remove noise, outliers, and inconsistencies. Perform feature engineering to extract relevant features from the raw sensor data. Normalize or scale the features as necessary for the machine learning algorithms.

Model Development:
Design and implement the Driving Decision Strategy (DDS) using machine learning techniques. Develop a genetic algorithm-based approach to optimize the driving strategy by analyzing both external and internal factors. Implement machine learning models such as MLP (Multi-Layer Perceptron) and RF (Random Forest) for comparison with the DDS.
Training and Evaluation:
Split the preprocessed data into training and testing sets. Train the DDS model and other machine learning models on the training data. Evaluate the performance of each model using appropriate metrics such as accuracy, precision, recall, and F1-score. Compare the performance of the DDS with MLP and RF models to validate its effectiveness.
Model Improvement:
Fine-tune hyperparameters of the DDS and other models to optimize performance. Explore ensemble methods or hybrid approaches to further improve the driving decision strategy.
Validation and Testing:
Validate the DDS model using real-world driving scenarios or simulated environments. Conduct extensive testing to ensure the robustness and reliability of the DDS in various conditions.
Results Analysis and Interpretation:
Analyze the results of the experiments and compare the performance of the DDS with other models.
Interpret the findings to understand the impact of considering internal vehicle factors on driving strategy optimization.
Documentation and Reporting:
Document the entire methodology, including data collection, preprocessing, model development, training, and evaluation. Prepare a comprehensive report summarizing the project objectives, methodology, results, conclusions, and recommendations for future work.
Presentation and Dissemination:
Present the findings of the project to stakeholders, researchers, and the wider community through presentations, papers, and conferences. Share the codebase, datasets, and documentation to facilitate reproducibility and further research in the field.
By following this methodology, the project aims to develop and validate a Driving Decision Strategy based on machine learning that improves the driving behaviour of autonomous vehicles by considering both external and internal factors.

3. ALGORITHM

RANDOM FOREST

This model has three random concepts, randomly choosing training data when making trees, selecting some subsets of features when splitting nodes and considering only a subset of all features for splitting each node in each simple decision tree. During training data in a random forest, each tree learns from a random sample of the data points. Random Forest is a supervised learning algorithm. Like you can already see from its name, it creates a forest and makes it somehow random. The -forest II it builds, is an ensemble of Decision Trees, most of the time trained with the -bagging ll method. The general idea of the bagging method is that a combination of learning models increases the overall result. To say it in simple words: Random forest builds multiple decision trees and merges them together to get a more accurate and stable prediction. One big advantage of random forest is, that it can be used for both classification and regression

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problems, which form the majority of current machine learning systems. We will talk about random forest in classification, since classification is sometimes considered the building block of machine learning. A random forest is a supervised machine learning algorithm that is constructed from decision tree algorithms. 14 A random forest is a machine learning technique that's used to solve regression and classification problems. It utilizes ensemble learning, which is a technique that combines many classifiers to provide solutions to complex problems. A random forest algorithm consists of many decision trees. The 'forest' generated by the random forest algorithm is trained through bagging or bootstrap aggregating. Bagging is an ensemble meta-algorithm that improves the accuracy of machine learning algorithms. The (random forest) algorithm establishes the outcome based on the predictions of the decision trees. It predicts by taking the average or mean of the output from various trees. Increasing the number of trees increases the precision of the outcome.

GENETIC ALGORITHM

The genetic algorithm is a method for solving both constrained and unconstrained optimization problems that is based on natural selection, the process that drives biological evolution. The genetic algorithm repeatedly modifies a population of individual solutions. The genetic algorithm can address problems of mixed integer programming, where some components are restricted to be integer-valued. 17 • A genetic algorithm is an adaptive heuristic search algorithm inspired by "Darwin's theory of evolution in Nature." • It is used to solve optimization problems in machine learning. It is one of the important algorithms as it helps solve complex problems that would take a long time to solve. • Genetic Algorithms are being widely used in different real-world applications, for example, Designing electronic circuits, code-breaking, image processing, and artificial creativity.

4.UML DIAGRAM

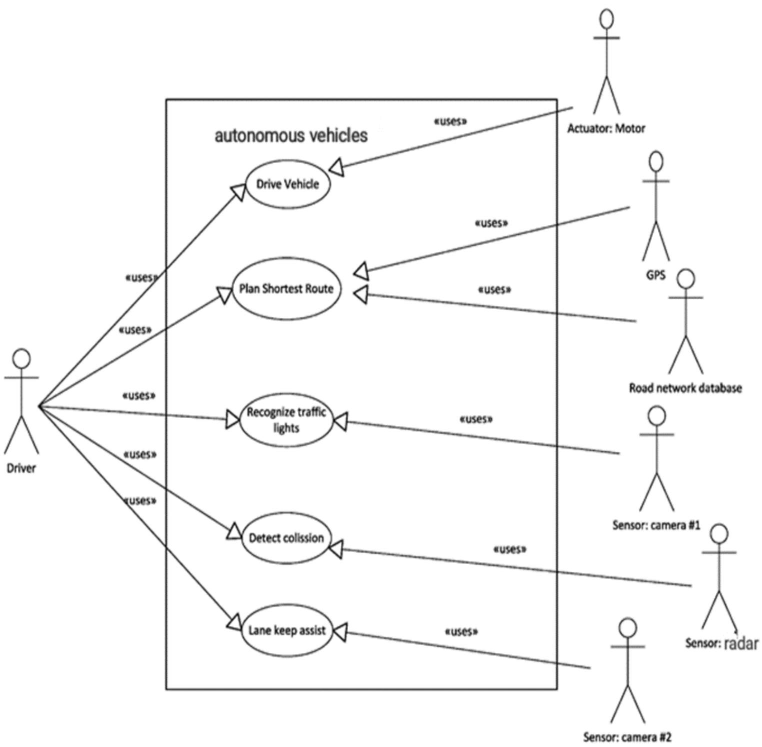

Fig. Usecase Diagram

5. RESULTS AND DISCUSSIONS

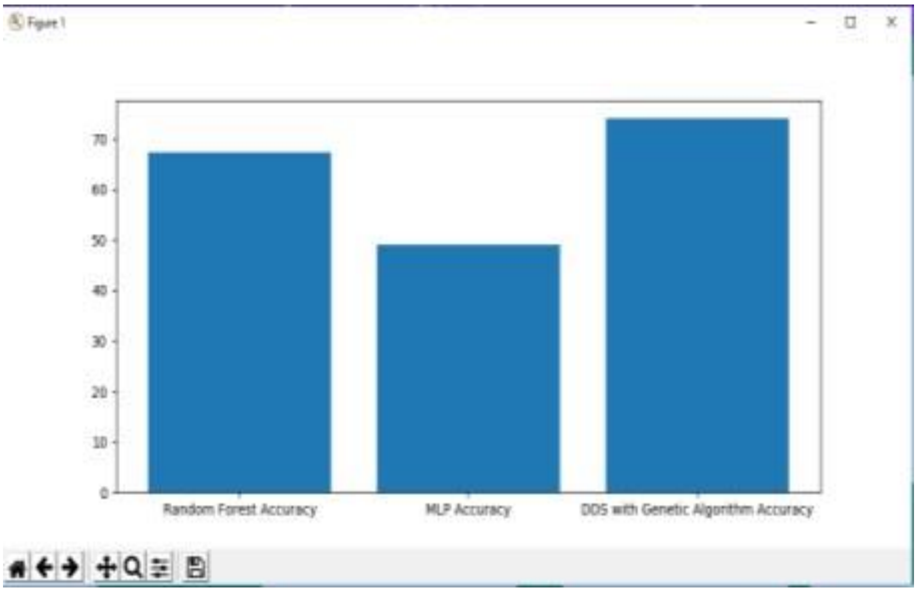

Fig. Accuracy Comparsion Garph

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